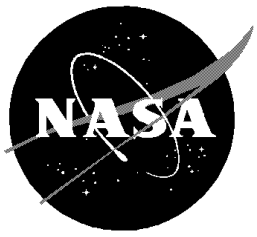
MicroElectroMechanical Systems

Payload Integration Plan

Basic
February 1998



National Aeronautics and
Space Administration

Lyndon B. Johnson Space Center
Houston, Texas

DESCRIPTION OF CHANGES TO

PAYLOAD INTEGRATION PLAN

SPACE SHUTTLE PROGRAM

AND

MICROELECTROMECHANICAL SYSTEMS

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NSTS 21424

PAYLOAD INTEGRATION PLAN

SPACE SHUTTLE PROGRAM

AND

MICROELECTROMECHANICAL SYSTEMS

FEBRUARY 2, 1998

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PREFACE

This Payload Integration Plan (PIP) is the customer and National Aeronautics and Space Administration (NASA) agreement on the responsibilities and tasks which directly relate to integration of the payload into the Space Shuttle and includes identification of tasks that the NASA considers as standard and nonstandard services.

Signature of this document constitutes technical agreement on tasks to be performed, including standard and nonstandard services. Upon provision of required funding, the standard and nonstandard services identified will be implemented by the Space Shuttle Program (SSP). The launch date shown in this PIP is for planning purposes only.

Further understanding of SSP operations and the associated payload-unique requirements may indicate the need for additions to or deletions from the nonstandard services. This can be accommodated by amendment of the PIP.

Issues which are yet To Be Resolved (and labeled "TBR" in this PIP) and additional details are documented in appendix A. Information not at issue but which is yet To Be Determined is labeled "TBD" and documented in appendix B.

CONTENTS

1.0 INTRODUCTION

The National Aeronautics and Space Administration (NASA) and the United States Air Force Space and Missile Systems Center Operating Location - AW (USAF/SMC/OL-AW) plan to launch and operate MicroElectroMechanical Systems (MEMS) using the Space Shuttle. Three additional launches of this payload are planned.

The MEMS will fly as a complex secondary payload.

The payload is further categorized as a middeck payload which requires processing at John F. Kennedy Space Center (KSC) for such things as buildup, battery installation, or checkout. This payload may also require Lyndon B. Johnson Space Center (JSC) processing.

The Space Shuttle Program (SSP) shall be composed of and represented by the JSC and the KSC. The MEMS shall be represented by USAF/SMC/OL-AW.

This plan provides the management roles and responsibilities, and a definition of the technical activities, interfaces, and schedule requirements to accomplish the integration, launch, on-orbit operation, and postlanding operations of the USAF/SMC/OL-AW payload with the Space Shuttle. All services to be furnished by the SSP to the customer under this PIP shall be furnished by the SSP using its best efforts.

2.0 MANAGEMENT RESPONSIBILITIES

The responsibility for assuring the definition, control, implementation, and accomplishment of activities identified in this document is vested with the SSP at the JSC and MEMS with the USAF/SMC/OL-AW. Hereafter in this PIP, the USAF/SMC/OL-AW will be referred to as the customer and the MEMS will be referred to as the payload.

2.1 Joint Responsibilities

The SSP and the customer will support the necessary integration activities, both analytical and physical, identified in this plan and according to the schedules contained in section 15.0. The SSP and the customer will staff interface working groups with technical personnel responsible for accomplishment of integration tasks. Interface working groups include management, crew

compartment, structural/mechanical/materials, avionics, thermal, flight planning, flight operations.

2.1.1 Documentation.- Primary documentation for payload integration into the Orbiter consists of the PIP, PIP annexes, data submittals, and appropriate Interface Control Annexes (ICAs).

The PIP, PIP annexes, data submittals, payload-unique ICA, and associated changes will be jointly approved by the SSP and the customer. When the customer is authorized to provide or specify requirements in a PIP annex or an ICA, these requirements are subject to SSP approval. Configuration control will be initiated upon signature approval. The SSP will maintain configuration control of the cited documentation in accordance with Program Definition and Requirements, NSTS 07700, Volume IV, Space Shuttle Configuration Management Requirements with the exception of Launch Site Support Plan Annex, Annex 8, which will be maintained by KSC in accordance with Payloads Configuration Management Handbook, KSC KHB-8040.4.

Unless otherwise stated within this document, all inconsistencies shall be resolved by giving precedence in the following order:

a. Safety Policy and Requirements for Payloads Using the Space Transportation System, NSTS 1700.7B, and Space Transportation System Payload Ground Safety Handbook, SAMTO HB S-100/KHB 1700.7, as modified by any NASA-approved waivers

b. Payload Integration Plan

c. Payload Interface Control Annexes referenced in the Payload Integration Plan

d. Annexes/data submittals to the Payload Integration Plan

e. Applicable documents of the Payload Integration Plan other than those above

2.1.2 Reviews.- The customer will provide support, as required, for the following reviews which will be implemented to assess the cargo integration process as described in Space Shuttle System Payload Accommodations, NSTS 07700, Volume XIV. Support may be data input, telecon, or designated representative, as agreed by the SSP and customer.

a. Payload Safety Reviews (PSRs)

b. Cargo Integration Review (CIR)

c. Flight Operations Review (FOR)

d. Ground Operation Review (GOR)

e. Payload Readiness Review (PRR)

f. Flight Readiness Review (FRR)

g. Flight Manager Integrated Product Team (IPT) - periodically

2.1.3 Proprietary Data.- In the event any of the data which the customer is required to furnish as part of the payload integration and safety process qualifies under the law as a trade secret or commercial or financial information and is confidential or privileged, and the customer desires to continue protection of such data, the customer shall mark the data with the following notice. NASA will thereafter treat the data in accordance with the notice.

NOTICE

These data embody trade secrets or commercial or financial information and are confidential or privileged, and shall not be used or disclosed other than for payload integration, safety, and associated launch services without prior written permission of the customer.

2.2 Space Shuttle Program Responsibilities

The SSP is responsible for integration of the payload into the Space Shuttle, including analytical integration, integrated flight design, integrated flight operations, and compatibility with other cargo elements that share the same flight. The SSP is also responsible for assuring that any other SSP activities required to support the payload flight are accomplished. The SSP is responsible for specifying to the customer all SSP requirements in the appropriate timeframe.

The KSC is responsible for Space Shuttle Launch and Landing (L&L) support which includes agreed-upon facilities and services, physical integration of the payload(s) and integrated checkout, ground integration of the payload and Space Shuttle, and postlanding activities.

2.3 Customer Responsibilities

The customer is responsible for the design, development, test, performance, and safety of the payload and Ground Support Equipment (GSE), as well as for providing support to the SSP analytical and physical integration activities identified in this PIP. The customer is also responsible for the buildup and checkout of the payload and is responsible for responding in the appropriate timeframe to SSP requirements set forth in this document. The customer is responsible for identifying to the SSP all payload problems which may affect SSP milestones, as identified in section 15.0, and shall discuss with the SSP a plan to resolve the problem(s).

The customer will support the Certification of Flight Readiness (COFR) process as described in NSTS 07700, Volume XIV.

2.4 Authority and Responsibilities of the Space Shuttle Commander

The authority and responsibilities of the Space Shuttle commander are as stated in The Authority of the Space Transportation System (STS) Commander, 14 CFR 1214.7. The Space Shuttle commander has absolute authority to take whatever action is necessary to ensure the safety and well-being of all personnel and equipment onboard.

2.5 Authority and Responsibilities of the Payload Commander

For missions with extensive crew training requirements and/or complex crew interactions, a payload commander may be designated. The payload commander will be responsible for working with the payload mission managers to identify and resolve issues associated with experiment assignments, training, crewmember qualification, and operational constraints. Per paragraph 2.4, ultimate onboard authority for the successful execution of the flight rests with the Space Shuttle commander.

2.6 Authority and Responsibilities of the Mission Management Team and the Cargo Management Team

2.6.1 Mission Management Team.- The authority and responsibilities of the Mission Management Team (MMT) are established in Space Shuttle Operations, NSTS 07700, Volume VIII.

The MMT will function as a program-level oversight group to review the status of countdown and flight activities and to make programmatic decisions outside the authority of the launch and flight teams. When necessary to deviate from established Launch Commit Criteria (LCC) or Flight Rules (FRs) to safely conduct SSP operations or to meet mission objectives, the single approval authority for such actions is the MMT chairman. The single representative to the MMT on matters involving the Shuttle cargo is the Flight Manager, SSP.

2.6.2 Cargo Management Team.- The customer's interface to the MMT is through membership on the Cargo Management Team (CMT). This team, which is chaired by the Flight Manager, SSP, consists of SSP and customer management representatives who have the authority and technical knowledge to make final programmatic recommendations to the MMT on issues which affect the payload. CMT membership, responsibilities, and functions are payload specific and are addressed further in the Payload Operations Workbook, JSC-27508.

3.0 PAYLOAD DESCRIPTION AND MISSION OVERVIEW

This section contains a general payload description and mission overview. It is not intended to specify requirements or constraints.

3.1 Payload Description

The payload examines the performance, under launch, microgravity, and reentry conditions of a suite of MEMS devices, accelerometers, gyros, and environmental and chemical sensors. The MEMS payload is self-contained and requires activation/deactivation only. All experiment monitoring and data recording is done through integrated components. Power, however, is required from just prior to ascent through deorbit. The payload configuration is shown in figure 3-1.

3.2 Mission Overview

3.2.1 Integrated Ground Operations.- After the payload is initially prepared, it is transported to the Orbiter integration facility. The payload is installed into the Orbiter at the launch pad, and interfaces verified.

The payload will utilize one middeck locker and a modified door (front panels removed). An accelerometer and mounting plate will be attached to the inside back of the middeck locker prior to insertion into the Orbiter. A power cable will be connected to the payload's locker during installation into the Orbiter. Prior to launch, the payload will be powered on and left on through deorbit.

3.2.2 Flight Operations.- The flightcrew will be available to support any status checking and/or contingency operations for the payload. The payload is self-contained and under normal operating conditions will only require the crew to periodically check the power status of the payload.

3.2.3 Postlanding.- After wheel stop, the payload will be powered off. The entire locker will be removed as soon as possible and turned over to the customer or the customer's representative for deintegration and data retrieval.

4.0 MISSION OPERATIONS

The mission operations section includes a definition of requirements and constraints by mission phase.

4.1 Payload Control Parameters

The payload control weight and payload control dimensions define maximum weight and dimensions of the payload for SSP mission planning purposes. A payload may not exceed its control weight or control dimensions without SSP approval.

The payload control weights are as follows:

Payload - 50 pounds (22.73 kg)
Total - 50 pounds (22.73 kg)

Payload control dimensions, including dynamic and access clearances are one locker volume.

For payloads replacing a middeck locker, the customer shall provide weight, center of gravity (c.g.), and configuration drawings to the Interface Control Annex, NSTS 21000-ICA. The weight and c.g. will be in accordance with NSTS 21000-IDD-MDK.

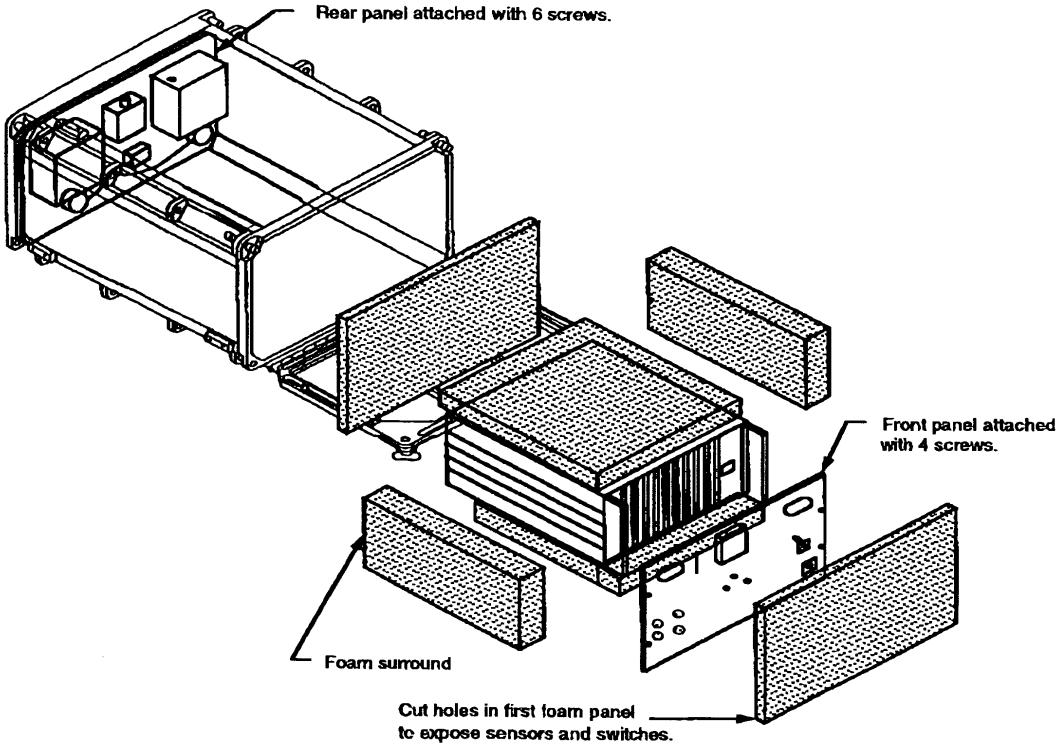


Figure 3-1.- The MEMS configuration.

For payload items to be stowed or installed in the middeck, the customer at the time of manifesting, will submit engineering drawings of all payload-provided hardware to the Crew Compartment Engineer. The customer will provide the flight hardware to JSC no later than 6 weeks prior to launch to support final stowage for flight and the Flight Crew Bench Review.

4.2 Operational Requirements and Constraints

The following payload operational requirements and constraints will be used in flight planning and implementation of the Space Shuttle and payload mission. Requirements that impose flight design and/or crew activity constraints will be implemented to the extent practical within primary payload objectives or mission objectives as determined by the SSP.

4.2.1 Launch Readiness.- The payload will be in final lift-off configuration when installed in the Orbiter and the payload activation is completed by the ground crew. At this time, the payload will be capable of sustaining this configuration indefinitely without access or SSP support. Exceptions to this must be negotiated with the SSP and documented in section 9.3.

4.2.2 On-orbit.- The payload will have been activated by the ground crew during prelaunch, and flightcrew operations only consist of daily payload status checks (Note: This could also include fan filter checks). Customer-provided displays and controls will be used by the flightcrew to periodically verify power is being supplied to the payload or to perform off-nominal procedures (such as fuse replacement) on the payload to the extent practical within primary payload objectives or mission objectives as determined by the SSP.

4.2.2.1 On-orbit Attitude: No on-orbit requirements

4.2.2.2 Thermal Environment: None

4.2.2.3 Photographic Coverage: The customer desires at least one documentary photo of on-orbit payload operations.

Shared usage of the Orbiter standard photographic equipment identified in section 7.1 will be provided by the SSP as a nonstandard service.

4.2.2.4 Equipment Restraint: None

4.2.2.5 Other Constraints: None

4.2.3 Safe Without Services.- The SSP-provided services such as power, cooling, ventilation, etc., may not be available under certain conditions; i.e., postlanding, ferry flights, or certain KSC operations. In this event, the customer is responsible to ensure that the payload does not present a hazard to the Space Shuttle or to personnel, while maintaining design requirements. For loss of normal services during the mission, the payload design must comply with the safety requirements as defined in NSTS 1700.7B, with contingency safing power as defined in section 5.4.

5.0 PAYLOAD-TO-SPACE SHUTTLE INTERFACES

The payload must be compatible with the Space Shuttle middeck interfaces as defined in Shuttle/Payload Interface Definition Document for Middeck Accommodations, NSTS 21000-IDD-MDK. The Space Shuttle-to-payload standard and unique interfaces are specified in NSTS 21424, ICA. Operational interfaces will be specified in the ICA.

5.1 Structural/Mechanical/Materials Interfaces

Not applicable

5.2 Cable Interfaces

The payload will use the standard SSP-provided direct current (dc) power cables to interface with a utility outlet as described in NSTS 21000-IDD-MDK.

5.3 Display and Control Interfaces

The payload shall provide its own unique Display and Control (D&C) for interface with the flight or ground crew. This D&C information will be provided by the customer to the Payload Officer.

Operational D&C nomenclature will be defined in payload-unique ICA.

5.4 Electrical Power Interfaces

Before installation in the Orbiter, power may be supplied to the payload using customer-provided or SSP-provided GSE (nonstandard service) as negotiated in Annex 8.

The payload electrical power requirements shall not exceed the allocations defined in NSTS 21000-IDD-MDK. The maximum continuous and peak power requirements are listed in table 5-1, and the Space Shuttle/payload interface voltage for the peak power value is defined in NSTS 21000-IDD-MDK.

Table 5-1.- ELECTRICAL POWER REQUIREMENTS

Source	Post-Installation	Ascent	On-orbit Operation		Descent	Post-flight
			Pre-operation	Post-operation		
a. Orbiter bus (dc)	48 W (74 W)	48 W (74 W)	50 W (78 W)	50 W (78 W)	50 W (78 W)	53 W (79 W)	N/R
b. Safing power*	N/R	N/R	N/R	N/R	N/R	N/R	N/R

*Safing power is the power required by the payload to reconfigure from a nonsafe mode to a safe mode before permanent termination of power. Time limits shall be specified.

(cont - continuous; Value inserted where interface is required, N/A inserted where interface is not available, and N/R inserted where interface is not required; peak power values are identified by parenthesis.)

The values listed in table 5-1 will be verified by test of the flight configuration with the results submitted to the SSP either at or before the Flight Planning and Stowage Review (FPSR).

The specific power profile will be defined by the customer in Annex 2. Loss of Orbiter-supplied power on-orbit to the payload shall, as a minimum, require manual reconfiguration of Orbiter power to restore power to the payload. The power will nominally be restored within 15 minutes of payload power loss detection.

The total energy shall not exceed 12 kWh/mission (assuming a 10 day mission).

5.5 Command Interfaces

Not applicable

5.6 Telemetry and Data Interfaces

Not applicable

5.7 Thermal Interfaces

Not applicable

The payload will operate continuously throughout ascent, on-orbit, and descent phases of the mission. The touch temperatures of crew accessible panels and controls shall not exceed 120° F.

Energy dissipation rates by mission phase are listed for the payload in table 5-2:

Table 5-2.- MEMS AVERAGE COOLING REQUIREMENTS

Source	Post-installation	Ascent	On-orbit Pre-operations	On-orbit Operations	On-orbit Post-operations	Descent
Orbiter cabin air	48 W	48 W	50 W	50 W	50 W	53 W

6.0 ENVIRONMENTAL ANALYSES AND INTERFACES

Standard Space Shuttle/payload natural and induced environmental interfaces, including structural loads, thermal, contamination, shock, vibration, acceleration and acoustics, are contained in NSTS 21000-IDD-MDK.

Environmental interface analyses will be conducted to determine physical and functional interface compatibility of the payload and the Space Shuttle. Specific analyses are described in the following paragraphs.

6.1 Structural Loads and Deflections

The customer is responsible for verifying compatibility with the Orbiter loads as defined NSTS 21000-IDD-MDK. The customer will assure compliance of the payload by providing a test report, if required, including structural test data and analysis.

6.2 Thermal Environments and Interfaces

The customer shall provide a thermal report, if required, which includes test data and analyses to assure the payload compatibility with the SSP-defined thermal environment found in NSTS 21000-IDD-MDK. The payload thermal report will be used by the SSP to determine that the resulting thermal environments are compatible with the Orbiter. A thermal integrated assessment, if required to assure compatibility, will be performed by the SSP utilizing a payload-provided thermal report.

6.3 Electromagnetic Interference/Electromagnetic Compatibility

The customer is responsible for assuring that the payload meets the induced electromagnetic interference environment and that the payload complies with the radiated and conducted emissions and bonding requirements defined in NSTS 21000-IDD-MDK. The specific characteristics of the payload Radio Frequency (RF) Systems Data and Electromagnetic Compatibility (EMC) Test Data as defined in NSTS 21288 shall be submitted to Integration Engineering for review and evaluation.

6.4 Contamination Control

The customer is responsible for assuring that the payload is compatible with the induced contamination environment and complies with offgassing requirements defined in NSTS 21000-IDD-MDK. In addition, certain materials and equipment requirements apply during ground operations in (or close proximity of) the Orbiter. The customer will comply with these requirements as defined in Limitations for Nonflight Materials and Equipment Used in and Around the Space Shuttle Orbiter Vehicles, NSTS 08242; and conversely, the customer shall assure that the presence of any allowed material, chemical, or gas will have no adverse effect on the payload.

Prior to installation into the locker, the external surface of the payload will be visually inspected and cleaned as necessary.

Specific facility operational requirements are contained in KSC Payload Facility Contamination Control Requirements/Plan, K-STSM-14.2.1; Shuttle Facility/Orbiter Contamination Control Plan, KVT-PL-0025; and Payload Facility Contamination Control Implementation Plan, KCI-HB-5340.1.

6.5 Shock, Vibration, Acceleration, and Acoustics Environments

The customer is responsible for assuring that the payload is compatible with the shock, vibration, acceleration, and acoustic environments defined in NSTS 21000-IDD-MDK. Report(s) shall be provided, if required, by the customer to reflect compliance with the middeck environmental requirements of NSTS 21000-IDD-MDK. If the payload generates continuous or intermittent noise in the crew compartment, the customer shall provide an acoustics report to Payload Integration Engineering no later than 2.5 months prior to launch.

6.6 Ground Environmental Requirements

The environment of the ground operations facilities at the launch site is specified in Launch Site Accommodations Handbook for Payloads, K-STSM-14.1.

Ground handling loads are always less than flight loads.

6.7 Materials and Processes

Materials and processes will be in accordance with NSTS 1700.7B.

7.0 INTEGRATION HARDWARE

Responsibilities for integration hardware are defined in the following paragraphs.

7.1 Space Shuttle Program-provided Hardware

The following hardware will be provided by the SSP:

a. One 28 V dc power cable

b. One middeck locker with modified locker door panel

c. Air sample container (SDD46108778-302)

7.2 Customer-provided Hardware

The following hardware will be provided by the customer:

a. MEMS flight hardware

b. Ground power supplies, etc.

c. Control panel and/or training mockup

8.0 FLIGHT OPERATIONS

This section defines the flight design, flight activity planning, flightcrew and flight controller training, and flight operations support activities required for Space Shuttle/payload integration.

8.1 Flight Design

The SSP will be responsible for performing integrated flight design. Constraints for flight design are defined in section 4.0. The customer will provide flight design information in Annex 2.

8.2 Flight Activity Planning and Flight Operations Integration

8.2.1 Flight Plan.- The JSC will be responsible for all crew activity planning and will develop an integrated Space Shuttle/payload Flight Plan to support the flight. The plan will be developed using customer-supplied payload crew activity requirements. The customer will provide these requirements to the Payload Officer.

8.2.2 Data Submittal Requirements for Flight Operations Integration.- The customer is responsible for development and verification of the payload data submittals as specified in table 8-1. The customer is to provide this data to the Lead Payload

Officer or designated representative per the schedule in table 8-1. At the FOR, the customer will verify and sign a written statement that all necessary payload data is implemented into the flight documentation. Details on these data submittals are available in JSC-27508.

Table 8-1.- DATA SUBMITTAL REQUIREMENTS

Payload data	Submittal deadline	Flight document containing data
Customer Flight Control Team & Launch OPS Team/Customer Support	L-6 months	JOIP
Formal letter specifying MCC/JSC POCC/CSR support facility requirements signed by customer	L-6 months	N/A
Nominal, backup, and contingency procedures	L-6 months	a. Payload Operations Checklist b. Payload Systems and Data Malfunction Procedures
Payload switch configuration requirements (Ascent/Entry/ Postlanding)	L-6 months	a. Ascent Switchlist b. Payload Operations Checklist
Malfunction procedures	L-6 months	Payload Systems and Data Malfunction Procedures
IFM procedures	L-6 months	Payload Systems and Data Malfunction Procedures
Formal letter listing all operational hazard controls jointly signed between payload organization and DO6	L-6 months	a. Payload Operations Checklist b. Flight Rules Annex
Unique payload data collection requirements	L-6 months	a. Flight Plan b. Flight Rules Annex

The customer is also required to provide schematics/diagrams to support the following processes:

Flightcrew procedures development - Specific diagram/schematic requirements and delivery dates will be defined in the PIP and/or coordinated with the Lead Payload Officer or designated representative.

8.2.3 MCC/JSC POCC/CSR Support Facility Requirements.- The payload will be supported by the Department of Defense (DOD) Representative in the DOD Payload Operations Control Center (POCC) (Bldg. 30M Room 336). No additional capabilities to the DOD POCC will be required for the payload.

8.3 Training

The SSP is responsible for assessing the training requirements for the flightcrew and flight controllers to support the flight. Payload-unique training will require SSP and customer resources as defined below.

The customer will provide a payload familiarization briefing at JSC to the flightcrew members, SSP flight controllers, and SSP instructor personnel. This briefing will precede other required payload training, and will be conducted according to the guidelines documented in Payload Familiarization Briefing Guidelines, JSC 25716.

To ensure that the flightcrew training schedule can adequately accommodate payload training requirements, the customer will submit the following initial estimates of payload training requirements when the PIP is baselined or earlier to the Mission Operations Directorate (MOD) Spaceflight Training and Facilities Operations (SFT&FO) branch. This data will, at a minimum, include the following:

a. A customer point of contact for payload training

b. Estimates for the amount of time necessary for flightcrew payload training at JSC and, if required, the customer's facility

c. Tentative L- dates for such training

d. Estimates of crew travel requirements to non-JSC area facilities

The SSP will provide generic Mission Control Center-Houston (MCC-H) facility training for customer representatives resident in the MCC-H during a mission. This training will be conducted by the use of workbooks and hands-on training for each representative. Key payload representatives are encouraged to participate in an applicable payload portion of an integrated simulation(s) to become familiar with MCC-H operations.

A Training Annex, Annex 7, is not required for this payload. Within 2 weeks after the decision to manifest the payload has been confirmed, the customer will further define their training requirements by providing a training plan encompassing, as a

minimum, the following payload training details for each planned training session:

a. A short title

b. The proposed location of the training

c. A proposed comprehensive timeframe in Launch minus (preferably weeks) format

d. Which crewmembers are required to participate

e. Planned hours for each crewmember

f. A summary of the training objectives

The SSP will review the customer's training plan proposals and reserves the right to negotiate alterations or amendments to the customer's training plan which will be in accordance with mutually acceptable customer training goals and objectives.

The customer will coordinate with the MOD SFT&FO branch flightcrew scheduler for selecting specific payload training dates and times and agrees to abide by established and customary scheduling protocols.

Unverified payload procedures will not be used for training. Additionally, crew training sessions are not to be used for the purpose of verifying payload operating procedures.

Required training dedicated to the payload must be planned and scheduled for completion by L-13 weeks.

Use of JSC facilities such as the Crew Compartment Trainer (CCT) or Full Fuselage Trainer (FFT) may be required for interface checkout.

The customer will provide opportunities for the flightcrew to train with the flight payload hardware. In addition, the customer will provide flight hardware or equivalent to JSC for utilization in the FFT, CCT, or Shuttle Mission Simulator (SMS) during secondary payload crew training.

If the SSP recommends integrated training among the manifested secondary payloads, the customer should support such integrated training by providing flight or equivalent payload hardware and customer personnel. Integrated training is defined as the

exercising of the procedures of two or more payloads and Orbiter activities during a given time segment of the crew Flight Plan.

Specific diagram/schematic requirements and delivery dates will be defined in the PIP and/or coordinated with the Lead Payload Officer or designated representative.

8.4 Flight Operations Control

The SSP will be responsible for integration of flight operations. The SSP flight control operations will be conducted from the JSC MCC-H using the Space Network (SN). When considered necessary by the SSP, the customer will provide a representative(s) at the MCC-H during the Space Shuttle/payload flight to provide a contact(s) for payload decisions to the SSP, to assess flight progress, and to coordinate operations interfaces between SSP and the customer. The basic plan, payload decision points, and agreements for these operations, including necessary procedures, will be identified in the payload data submittals to the Lead Payload Officer or designated representative.

8.5 In-flight Maintenance

All payload In-flight Maintenance (IFM) shall be designed so that safety requirements will not be compromised. Only IFM procedures reviewed and approved by the safety panel will be authorized. Any payload IFM requires real-time concurrence from the Space Shuttle commander.

9.0 LAUNCH AND LANDING SITE OVERVIEW

Payload-unique activities and an overview of L&L site activities are presented in this section. Overall SSP policy and requirements are shown in System Description and Design Data - Ground Operations, NSTS 07700, Volume XIV, Appendix 5. Ground processing details and customer-requested ground support (both nominal and contingency) are documented in Annex 8 by the Launch Site Support Manager (LSSM) according to the schedule shown in section 15.0.

In support of Annex 8 development, the customer participates in ground operations working group meetings that further define the payload L&L requirements and plan for the payload's implementation. All customer Technical Operating Procedures (TOPs) will be submitted no later than 55 days before use to the

LSSM for KSC review/approval. Specific payload requirements affecting integrated operations with the Orbiter will be documented in the Operations and Maintenance Requirements and Specification Document (OMRSD) (File II, Volume II). Prelaunch and postlanding support requirements not documented in the OMRSD will be documented in Annex 8. The customer also makes input to and supports the review schedule for SSP development of L&L operational procedures.

The SSP will take required photographs of the payload before and after installation in the Orbiter to support Flight Data File (FDF) development, flightcrew and flight controller training, and for possible in-flight contingencies. These photographic activities will be scheduled and coordinated with the customer.

Training or certification of training may be required for customer personnel performing certain payload ground processing activities. Health reports or physical examinations will be required for certain operations, such as deployment to non-Continental United States (CONUS) landing sites. Details are included in the Annex 8.

9.1 Customer Processing

Upon arrival at the launch site, payload hardware is delivered to an assigned area (provided as a nonstandard service) for postshipment customer inspection, functional checkout, and preparation for transfer to SSP control. Typically, the customer is responsible for these preintegration activities and utilizes customer-provided GSE.

The customer is responsible for labeling of hardware with any required toxic substance hazard decals prior to turnover to KSC or final stowage, as applicable. JSC will deliver the decals in sufficient time for affixing the decals prior to final payload stowage and closeout. More detailed information is contained in JSC-27508.

After these activities are completed, the payload is transferred to L&L control to begin the Orbiter integration process. Agreed-upon nonstandard services to be performed before Orbiter integration are: None.

9.2 Payload Integration

Not applicable

9.3 Orbiter Integration

Middeck payloads will be installed and any interface verification tests, closeout procedures, and payload-unique tests will be accomplished by the SSP.

Customer turnover times are typically 1.5 to 2 hours prior to installation to accommodate KSC preparation and transportation to the launch pad.

Agreed-upon nonstandard services to be performed at the pad for this payload are as follows:

Activation of the payload prior to launch

Payload turnover times will be documented in Annex 8. Installation requirements will be specified in the OMRSD.

9.4 Postlanding

9.4.1 Nominal Landing Processing.- If a flight ends at either KSC or Dryden Flight Research Facility (DFRF), items containing time-critical data must be offloaded from the Orbiter prior to Orbiter tow (nonstandard service). Removal of payload hardware will be top priority after necessary safing and crew egress activities are complete.

Requirements for early removal are documented in the OMRSD.

Early removal of entire middeck locker prior to Orbiter tow (nonstandard service) and turnover to the customer for data retrieval and deintegration is required.

9.4.2 Intact Abort Processing.- If an aborted flight lands at KSC or DFRF, the SSP will remove and disposition the payload using its best efforts.

If an aborted flight lands at a site other than KSC or DFRF, payloads in the Orbiter middeck will be removed and returned by the SSP to the launch site. If requested by the customer, transportation of the payload to a location other than the launch site is a nonstandard service.

Customer requirements for SSP support which exceed planned operations are provided as a nonstandard service. The customer

or the customer's representative is responsible for performing payload-unique operations (data removal, preparations for transporting, etc.) and for providing the personnel and GSE to conduct these operations. Within the transportation provisions for SSP GSE and personnel, the SSP will provide, on a space-available basis, transportation of payload-unique GSE and personnel to and from the landing site.

9.4.3 Early End of Mission Support.- The payload will not require Early End of Mission (EEOM) support.

10.0 SAFETY

10.1 General

The customer is responsible for ensuring that the payload (and GSE), including interfaces and operations, are safe. Payload (and GSE) design and operations must comply with the safety requirements defined herein. Payload compliance with the safety requirements is assessed by the SSP through flight (and ground) safety reviews (up to four) and safety certification. Successful completion of these safety reviews and safety certifications by the customer will result in approval by the SSP for (ground processing and) flight.

In order to preclude hazardous operations, full disclosure of all operating parameters, including but not limited to pressures, temperatures, and voltages and power, will be required. In addition, full disclosure of the contents, flammability, and Hydrogen-Ion concentration (pH) and toxicity of all substances including proprietary material used in or produced by any payload or experiment will be made. A list of all payload or other experiment test materials and experiment-specific utility chemicals to be used in spacecraft habitable modules will be submitted to the JSC toxicologist and the Payload Safety Review Panel (PSRP) executive secretary in accordance with the checklists, general format and timelines specified in Requirements for Submission of Test-Sample Materials Data for Shuttle Payload Safety Evaluations, JSC 27472, or its subsequent revisions.

The customer is responsible for certifying that controls of hazardous material is consistent with the methods/designs approved by the PSRP. The JSC Toxicologist will develop and manage the Hazardous Materials Summary Table (HMST) from the customer-supplied list as required for the PSRP review. The

customer will verify that (1) materials that are planned to be loaded are listed on the HMST, and (2) the materials loaded are on the approved planned loading list. Following the Flight Safety Phase III Review, the JSC Toxicologist will provide the customer with the preliminary HMST. The customer will return the HMST with the signed Verification 1 form which represents the final loading plan. Following SSP approval, corrections will be incorporated into the Final HMST at L-2 months and provided to the customer. Since loading will occur at various times, the customer will return Verification 2 forms and the As-loaded HMST when hazardous material loading actually occurs. Review and concurrence of the As-loaded list by the JSC Toxicologist will constitute the As-loaded list of Hazardous Materials for use by the flight team. Between Verification 1 and Verification 2, the SSP policy is to limit changes to the HMST to only allow deletions and/or reductions of concentration of the hazardous materials.

10.2 Payload Design and Flight Operations Requirements

The payload, including interfaces and operations will comply with the requirements of NSTS 1700.7B. The payload shall meet these requirements at the launch/landing sites and during flight and orbital operations.

All interaction/interface safety analyses will be performed by the customer for the payload interfaces with the Orbiter. In this analysis, failures identified in Shuttle Orbiter Failure Modes and Fault Tolerances for Interface Services, NSTS 16979, and the flight operations will be assessed by the customer. The analysis will define assumptions made by the customer with respect to Orbiter services and operations associated with hazardous payload functions. The analysis will identify potential payload failures which could propagate to the Orbiter and exceed the design criteria in NSTS 21424, ICA.

During real-time SSP operations, the SSP has final safety responsibilities. Payload organizations have the responsibility to support the SSP by providing expert advice on safety matters affecting the payload or its operation.

10.3 Ground Support Equipment Design and Ground Operations Requirements

Payload and GSE design, including interfaces and operations, will comply with the requirements of NSTS 1700.7B and SAMTO HB S-

100/KHB 1700.7, for launch site processing and postlanding operations including abort, contingency, and emergency landings. Other launch/landing site safety requirements may be applicable, depending upon assessment by the SSP of payload and GSE operations.

Hazardous and nonhazardous TOPs will be submitted to the LSSM for Launch Site Safety Office (LSSO) review. Hazardous TOPs must be approved by LSSO no later than 10 days before first use.

10.4 Safety Review Requirements

Implementation of the safety requirements of NSTS 1700.7B and SAMTO HB S-100/ KHB 1700.7 will be accomplished in accordance with Implementation Procedure for NSTS Payloads System Safety Requirements, NSTS 13830. Safety documentation will be provided by the customer to the appropriate SSP organization for each safety review: JSC for flight design/operations and KSC for ground design/operations. The safety review meeting will be scheduled approximately 45 days after receipt of an acceptable data submittal. Flight design and operations safety reviews will be coordinated/scheduled by the JSC safety office and the ground design and operations safety reviews will be coordinated by the KSC LSSM.

Flight and ground Phase III Safety Review(s), including closure of ground safety verification, and ground safety certification must be completed 30 days prior to payload and GSE delivery to KSC. The customer will be required to identify any open verification status items from the flight Phase III Safety Review, as reported in the Payload Flight Safety Verification Tracking Log, and provide rationale for acceptance of this condition prior to commencement of ground processing. Flight safety certification must be completed 10 days prior to the FRR.

When changes to design or operations of the payload/(GSE) are required subsequent to Phase III, the customer shall assess those changes for possible safety implications, including the effect on all interfaces. The assessment shall be forwarded to the JSC (and/or KSC) safety panel for review and approval. The assessment shall include the reason for the change and the safety impact, if any. New or revised hazard reports and support data shall be prepared when applicable and also submitted for approval. The need for a delta Phase III Safety Review will be determined by hazard potential involved. Satisfactory completion of all this activity is mandatory prior to launch.

All verification activities including post-Phase III Safety Review operations will be reported to the SSP Payload Safety Panel by procedure numbers, location where performed, and date as described in NSTS 13830.

For changes to GSE design and ground operations, the restriction is the changes must be approved by the LSSO and KSC safety panel prior to use of the GSE or procedure.

In conjunction with the FOR, payload configuration (including systems and procedures) will be reviewed by the SSP with customer participation to highlight safety concerns and resulting operations decisions. In support of this review, the customer will provide the payload officer and the JSC SSP PSRP with any additional safety-related data which may impact flight operations decisions.

10.5 Biomedical Payloads/Experiments

Not applicable

11.0 INTERFACE VERIFICATION AND TESTING

The customer is responsible for verifying compatibility with the interfaces and environments specified in this PIP and the ICA. The interface verification requirements and planning will be negotiated and concurred with the SSP and the customer.

All payload-to-Orbiter interface verification requirements are to be identified and submitted by the customer in the OMRSD, in accordance with the schedule in section 15.0. Interfaces that cannot be verified prior to flight shall also be documented in the OMRSD with supporting rationale.

12.0 POSTFLIGHT DATA REQUIREMENTS

The SSP is responsible for Space Shuttle system monitoring and anomaly resolution. In the event of a Space Shuttle anomaly which would influence the execution of payload objectives, SSP will supply the Space Shuttle data as available to the customer for evaluation.

In the event of a payload anomaly, Space Shuttle data may be required for evaluation of the payload problem.

Postflight data listed below will be provided.

		Reqd	N/R	Remarks
a.	Documentary photograph	X		
b.	Orbiter Maneuvering System (OMS), Primary Reaction Control System (PRCS), and Vernier Reaction Control System (VRCS) firing history	X		
c.	Cabin temperature	X		
d.	Cabin humidity	X		
e.	Cabin pressure	X		
f.	Attitude, rates and accelerations	X		
g.	Pertinent crew logs	X		
h.	Flash Evaporator System (FES) and Water Dump data	X		
i.	Crew Compartment Environment Analysis from Grab Sample Bottles	X		Requires Mission Elapsed Time (MET) of when sample was taken

Note: Detailed listing of Closed Circuit Television (CCTV) and photographic requirements will be defined in the Remarks column (i.e., number of copies of photographic prints, transparencies, etc.)

13.0 SUMMARY OF NONSTANDARD AND CUSTOMER-FUNDED SERVICES

This section of the PIP identifies and sets forth all services to be performed by the SSP for the customer that are currently identified as nonstandard or customer-funded services. Except for additional nonstandard SSP services identified in the future, all other services to be provided by the SSP for the customer are standard services.

A summary of nonstandard services identified herein to be provided and priced to the customer for payload integration and operations follows:

L&L Site Support:

a. Provision of an assigned area at the launch site for customer integration and inspection, functional checkout, and preparation for turnover to SSP control.

b. Activation of payload prior to launch.

c. Early removal (prior to Orbiter tow) of entire middeck locker and turnover to the customer or the customer's representative for data retrieval. This includes landing at either KSC or DFRF.

Prior to initiation of individual nonstandard service(s), the performing SSP organization and the customer will jointly scope tasks, and the performing NASA organization will establish the estimate of governmental costs and provide it to the customer. The SSP will only initiate nonstandard service(s) with approval and funding of a PIP CR.

14.0 PAYLOAD INTEGRATION PLAN ANNEXES

As identified in other sections of this PIP, the following annexes/data submittals are required from the customer in the SSP standard format.

Annex 2 Part 1 - Flight Planning

ICA - Interface Control Annex

Annex 8 - Launch Site Support Plan

OMRSD - Operations and Maintenance Requirements and Specification Document

15.0 SCHEDULE

The attached schedule, figure 15-1, provides a summary of various technical areas requiring data exchange and/or products in support of the Space Shuttle/payload integration activities.

16.0 APPLICABLE DOCUMENTS

The following current issue* documents are applicable to the extent stated herein.

a. NSTS 1700.7B, Safety Policy and Requirements for Payloads Using the Space Transportation System, January 1989

b. NSTS 13830, Implementation Procedure for NSTS Payloads System Safety Requirements, current issue*

c. NSTS 21000-IDD-MDK, Shuttle/Payload Interface Definition Document for Middeck Accommodations, current issue*

d. NSTS 21424 ICA, Interface Control Annex

e. K-STSM-14.1, Launch Site Accommodations Handbook for Payloads, current issue*

f. NSTS 07700, Program Definition and Requirements, Volume IV-Book 1, Appendix H, Space Shuttle Configuration Management Requirements, current issue*

g. NSTS 07700, Volume XIV, Space Shuttle System Payload Accommodations, including Attachment 1 (ICD 2-19001) and Appendices 1-10, current issue*

h. KSC KHB-8040.4, Payloads Configuration Management Handbook, current issue*

i. NSTS 14046, Payload Verification Requirements, current issue*

j. Human Research Policy and Procedures for Space Flight Investigations, JSC 20483, current issue*

k. K-STSM-14.2.1, KSC Payload Facility Contamination Control Requirements/Plan, current issue*

l. KVT-PL-0025, Shuttle Facility/Orbiter Contamination Control Plan, current issue*

m. KCI-HB-5340.1, Payload Facility Contamination Control Implementation Plan, current issue*

n. SAMTO HB S-100/KHB 1700.7, Space Transportation System Payload Ground Safety Handbook, current issue*

o. NSTS 16979, Shuttle Orbiter Failure Modes and Fault Tolerances for Interface Services, current issue*

p. NSTS 08242, Limitations for Nonflight Materials and Equipment Used in and Around the Space Shuttle Orbiter Vehicles, current issue*

q. NSTS 21000-IDD-486, Shuttle/Payload Interface Definition Document for the Payload and General Support Computer (PGSC), current issue*

r. 14 CFR 1214.7, The Authority of the Space Transportation System (STS) Commander

s. NSTS 07700, Volume VIII, Space Shuttle Operations, current issue*

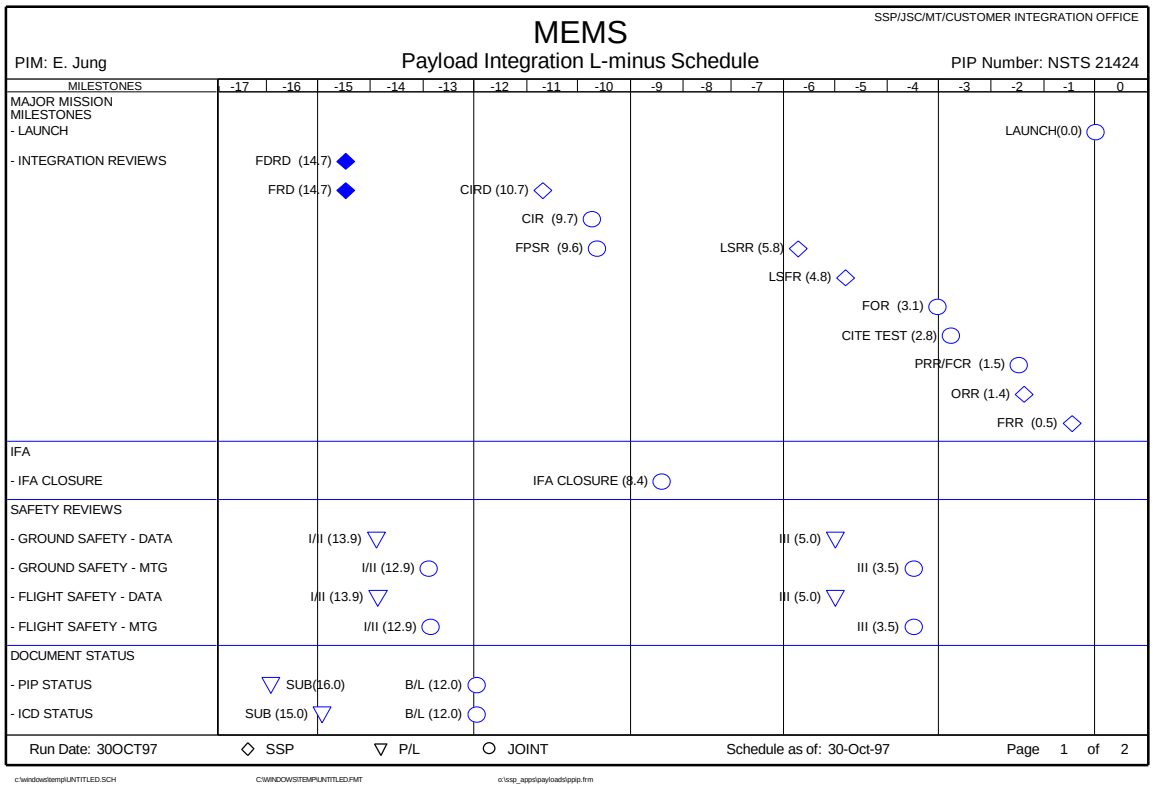
t. JSC 25716, Payload Familiarization Briefing Guidelines, current issue*

u. NSTS 21000-IDD-486, Shuttle/Payload Interface Definition Document for Payload and General Support Computer (PGSC), current issue*

v. JSC 27472, Requirements for Submission of Test-Sample Materials Data for Shuttle Payload Safety Evaluations, current issue*

w. JSC 27508, Payload Operations Workbook

*Current issue includes all future changes and revisions.



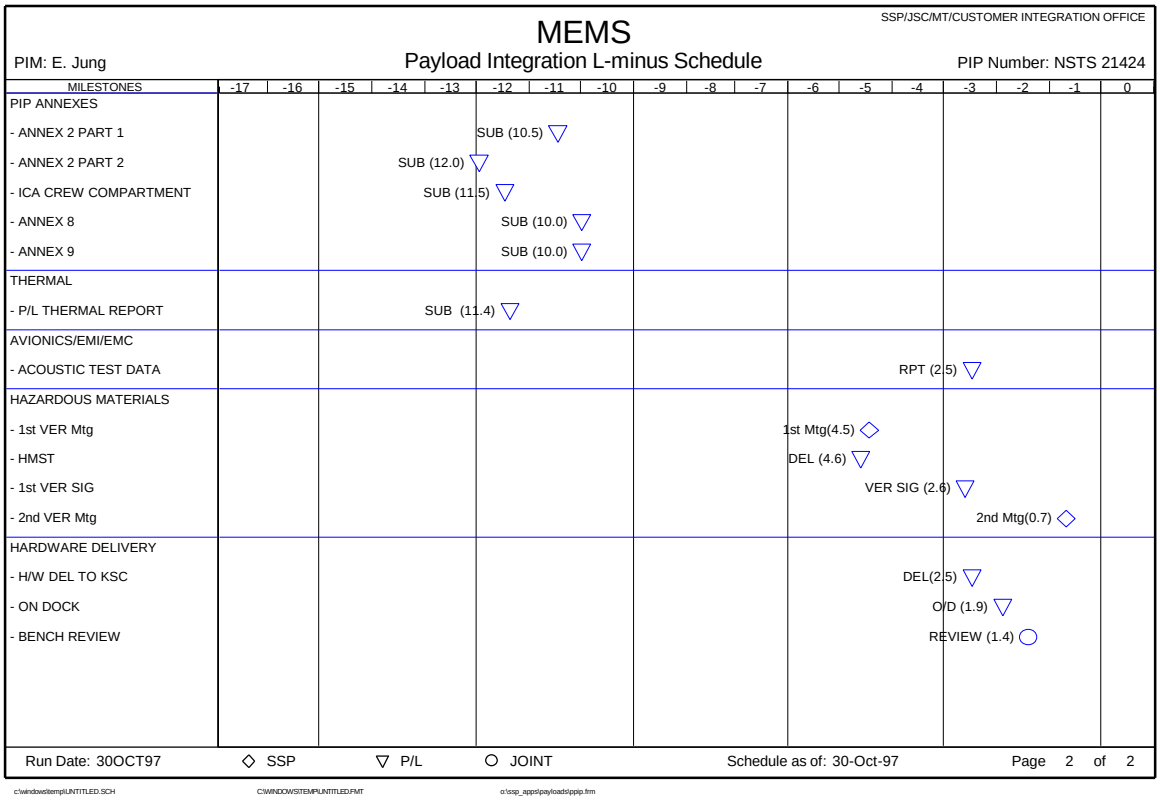


Figure 15-1.- Payload integration schedule.

APPENDIX A

TO-BE-RESOLVED ITEMS

None

APPENDIX B

TO-BE-DETERMINED ITEMS

None

APPENDIX C

ACRONYMS AND ABBREVIATIONS

ac	alternating current
c.g.	center of gravity
CCT	Crew Compartment Trainer
CCTV	Closed Circuit Television
CIR	Cargo Integration Review
CMT	Cargo Management Team
COFR	Certification of Flight Readiness
cont	continuous
CONUS	Continental United States
CR	Change Request
CRT	Cathode-Ray Tube
D&C	Display and Control
dc	direct current
DFRF	Dryden Flight Research Facility
EEOM	Early End of Mission
EMC	Electromagnetic Compatibility
EOM	End of Mission
F	Fahrenheit
FDF	Flight Data File
FES	Flash Evaporator System
FFT	Full Fuselage Trainer
FOR	Flight Operations Review
FPSR	Flight Planning and Stowage Review
FR	Flight Rule
FRR	Flight Readiness Review
GOR	Ground Operations Review
GSE	Ground Support Equipment
HMST	Hazardous Materials Summary Table
ICA	Interface Control Annex
ICD	Interface Control Document
IDD	Interface Definition Document
IFM	In-flight Maintenance
IPT	Integrated Product Team
JSC	Lyndon B. Johnson Space Center

kg	kilograms
KSC	John F. Kennedy Space Center
kWh	kilowatt hours
L&L	Launch and Landing
L-	Launch minus
LCC	Launch Commit Criteria
LSSM	Launch Site Support Manager
LSSO	Launch Site Safety Office
m	meter(s)
MCC-H	Mission Control Center-Houston
MEMS	MicroElectroMechanical Systems
MET	Mission Elapsed Time
MMT	Mission Management Team
MOD	Mission Operations Directorate
N/A	Not Applicable
N/R	Not Required
NASA	National Aeronautics and Space Administration
no.	number
OMRSD	Operations and Maintenance Requirements and Specification Document
OMS	Orbital Maneuvering System
PGSC	Payload and General Support Computer
pH	Hydrogen-Ion Concentration (Alkalinity)
PIP	Payload Integration Plan
POCC	Payload Operations Control Center
PRR	Payload Readiness Review
PSR	Payload Safety Review
PSRP	Payload Safety Review Panel
SFT&FO	Spaceflight Training and Facilities Operations
SMS	Shuttle Mission Simulator
SSP	Space Shuttle Program
SN	Spaceflight Network
TBD	To Be Determined
TBR	To Be Resolved
TOP	Technical Operating Procedure
TV	Television
USAF	United Stated Air Force
USAF/SMC/OL-AW	United States Air Force/Space and Missile Center/Operation Location - AW

VRCS	Vernier Reaction Control System
W	watt

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